Precision Nanoparticles

As world demand for energy increases, new technologies are needed to provide power while protecting the environment.

In the November 2009 issue of *Inside* Energy, the U.S. Department of Energy's Basic Energy Science Advisory Committee says that "fundamental advances are needed so that solar power, biofuels, and other alternative energy technologies can compete" and "make a significant contribution to U.S. and global energy problems." In the same article, others commented on the need for advancements, noting that "far higher performance levels" are needed in next generation technologies. Committee member George Crabtree added, "Those higher performance levels require breakthroughs." Advisory chair and research chemist John Hemminger underscored that thought saying, "the breakthrough that will yield a new solar cell will likely come from nanotechnology research."

One breakthrough now has been discovered.

By producing the smallest, most uniform semiconductor nanoparticles, this invention may offer the ability to develop new, more capable solar cells to capture untapped energy from the previously inaccessible portions of the solar spectrum.

A research team from Idaho National Laboratory (INL) and Idaho State University invented a scalable, revolutionary nanoparticle production technology using supercritical fluids called Precision Nanoparticles. This technology creates affordable, uniform nanoparticles (+ 0.2 nanometers) in a wide range of sizes (less than 1 to 100 nanometers). No other processes compare in producing nanoparticles with these size and uniformity restrictions.

How it Works

Precision Nanoparticles uses supercritical carbon dioxide to disrupt the hydrogen bonds of an organometallic material and

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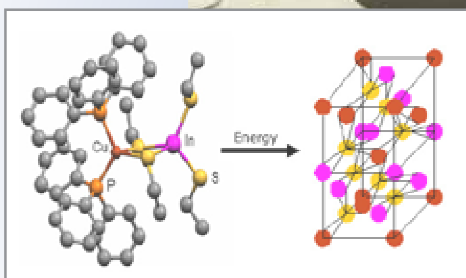
lower the material's decomposition temperature, making the process inexpensive. The supercritical fluid also acts as a solvent for leaving groups included in the material. A leaving group is an ion or substituent that detaches from a molecule, causing a reaction. The Precision Nanoparticles process uses a single-source precursor method, in which all the materials for the desired compound are included in the base material, along with the leaving group material.



The process uses a single-source precursor method that is energy-efficient and environmentally friendly.

Once the leaving group is detached, the remaining materials react to form the desired compound. Because the supercritical fluid dissolves the leaving groups very quickly, the remaining materials are driven rapidly towards equilibrium, creating very small and very uniform (+0.2 nanometers) nanoparticles.

Many traditional methods for producing nanoparticles are expensive, energy intensive, and environmentally dangerous. In addition, many nanoparticle production processes are used to generate small amounts of nanoparticles that can be used in laboratory experiments. In order to truly realize the power of nanotechnology, science and industry need processes such as the Precision Nanoparticles process that develop high-quality, affordable, uniform nanoparticles.

Using Nanotechnology for Next-Generation Solar Cells

Precision Nanoparticles are perfect for a variety of next generation nanotechnology applications. Among these technologies are third generation photovoltaic cells for capturing solar energy. The research team has already begun applying the nanoparticles produced by the Precision Nanoparticles process to research the potential of solar power.

If deployed as quantum dots across a solar cell, Precision Nanoparticles can harvest energy from larger, more productive portions of the solar spectrum than any previous solar cell. Such innovation is possible because of the nature of nanoparticles and the enhanced attributes of materials at the nanoscale.

Semiconductor nanoparticles (such as copper indium disulfide) have varying band gaps depending on their size. By precisely varying the size of the nanoparticle dots (and therefore the band gap), it is possible for nanoparticles of one material to more closely match the energy of photons across a wide range of wavelengths, resulting in more efficient photon absorption and conversion to electrical energy. By employing a band-gap matching scheme, the theoretical conversion efficiency of such solar cells is envisioned to be from 40 to 60% photon conversion to electricity, whereas current cells convert on 8 to 10%.

New and emerging technologies often can help society meet needs, especially increasing demands in areas like energy, water supplies, and medical treatment for diseases such as cancer.

Nanotechnology potentially offers the breakthroughs needed, if scientists, engineers, and industry can leverage the power of nanoparticles. Precision Nanoparticles provides a major leap forward in nanoparticles production by providing small, incredibly uniform nanoparticles at low costs.

For more information

Technical Contact

Bob Fox
(208)526-7844
robert.fox@inl.gov

Business Contact

Jason Stolworthy
(208) 526-5976
jason.stolworthy@inl.gov

www.inl.gov/techtransfer

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